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ABSTRACT

This document is one of a series of role plays that focus on science-related social issues of concern in contemporary public policy formation. The role plays are designed to help students develop information-processing and decision making skills needed to deal effectively with such issues. The role plays guide students in analyzing science related social issues by applying the concepts of science, technology, conflict, values, risks, costs, benefits, decisions, and public policy. The role play presented in this manual considers the dilemma faced by a community whose landfill is nearing capacity and faced with closure. The case is set in the fictional community of Hanson. Students are assigned roles representing Hanson City Council members, scientists, government officials, Hanson residents holding various views on the issue, and other interested individuals. The students participate in a simulated city council hearing to present arguments related to the pros and cons of various ways to manage Hanson's solid waste disposal in the future. Three major alternatives are considered: (1) build a waste-to-energy incinerator, (2) build a new landfill, and (3) institute a mandatory recycling program combined with a new landfill. Students are organized into groups representing the three positions and a decision making group, the city council. Through several days of research the groups compile evidence to support their respective positions and contribute the information to a classroom resource center for the use of all groups. The culminating exercise is a public hearing. A discussion analyzing the different viewpoints and the decision making and risk management processes concludes the activity. (DK)

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Oh, Garbage!
Decisions About Waste Disposal

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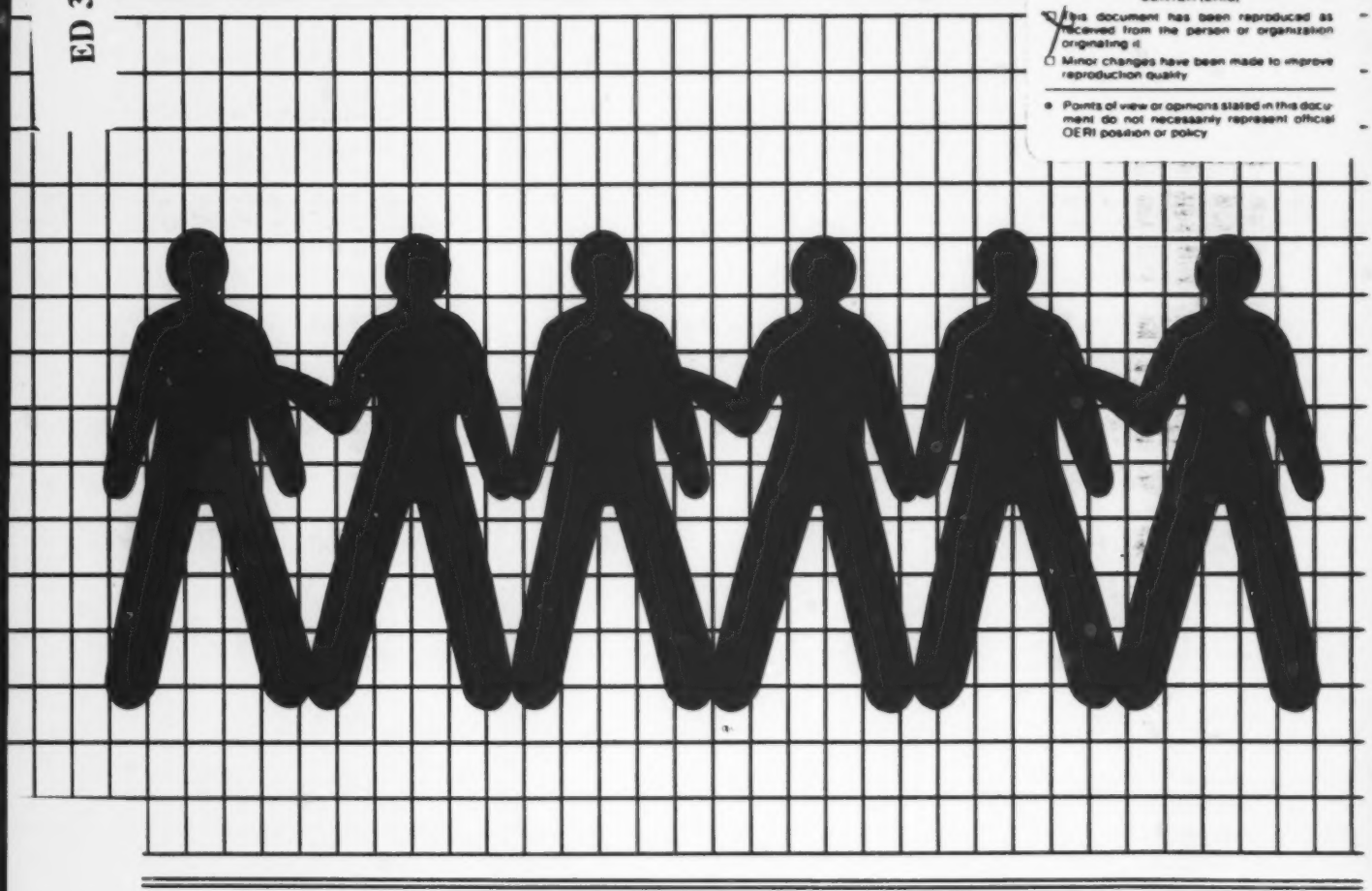

Creative Role Playing Exercises In Science And Technology

By Lynn Parisi and Janice Pearson

Social Science Education Consortium, Inc.

Boulder, Colorado

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OH, GARBAGE!
DECISIONS ABOUT WASTE DISPOSAL

CREATIVE ROLE-PLAYING EXERCISES
IN SCIENCE AND TECHNOLOGY SERIES

By Lynn Parisi and Janice Pearson

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Boulder, Colorado
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ACKNOWLEDGMENTS

The *Creative Role-Playing Exercises in Science and Technology Series* was originally developed as part of a three-year curriculum project conducted by the Social Science Education Consortium, Inc., between 1980 and 1983, with funding from the National Science Foundation. Bruce Tipple, formerly a staff associate with the SSEC and currently president of Learning Designs, conceptualized the series, developed the format in which the role plays were written, and supervised preparation of the role plays. This role play, while not developed as part of the original series, follows the model developed for that project.

For their assistance in completing the published version of these materials, appreciation is due to Gerald Marker and Ginny Jones for reviewing this role play, and Cindy Cook for coordinating production.

INTRODUCTION

Public perceptions of science and technology have undergone significant change over the past few decades. Fifty years ago, science was considered an activity confined to laboratories and research institutions; technology tended to be equated with progress. Increasingly, however, science and technology are becoming social issues. Developments in electronics, biology, and medicine have effected changes in many aspects of political, economic, and social life. The far-reaching impact of technology has caused scientists, government officials, and citizens to voice concern over such issues as resource depletion, environmental pollution, production of toxic wastes, and biomedical ethics and controls.

Today's citizens are not only affected by science-based developments, they are increasingly called upon, through their participation in the democratic political process, to affect public policy concerning the development and application of science and technology. The public policy agenda at all levels is filled with issues generated by advances in science and the application of these advances through technology. On one level, citizens must elect government representatives charged with the responsibility of deciding national issues such as nuclear weapons research and production, energy policy, land use policy, and resource development. In addition, the American people are called upon to vote directly on local and state issues with complex science or technology components. Such issues as transport of hazardous chemicals along Colorado highways, toxic waste dump sightings in Nevada, and field testing of artificially created bacteria on California farms are among those decided locally and statewide through public initiatives and referenda. Lay citizens affect public policy through citizen advisory boards, public meetings and hearings, and public information centers. Increasingly, federal agencies have been required by Congressional mandate to involve citizens directly in the formulation and implementation of science and technology policies. The Airport and Airways Development Act, Federal Water Pollution Control Act, Coastal Zone Management Act, and National Environmental Policy Act are among the laws including such mandates.

It is clear that issues such as those cited above have seriously complicated and challenged citizen participation in policy making. Informed and intelligent citizen participation in such issues increasingly requires three things: (1) a knowledge of technical and scientific facts; (2) an ability to recognize the interface between science and society – that is, to recognize the real and potential impact of science and technology on social, economic, and political conditions; and (3) decision-making skill – the ability to synthesize and process all this information in a systematic and rational way.

The role plays in this series were developed to help prepare students for participation as informed and interested citizens in the making or enforcement of public policy related to science and technology. Each role play focuses on a contemporary science-related issue and integrates the presentation of scientific and societal data with a risk assessment and decision-making exercise. All the role plays follow a standard procedure: students are divided into groups representing a decision-making body and pro, con, and compromise positions on a given issue. Students research their positions using provided data and library resources, ultimately using their findings to support their group's position in a simulated public or agency hearing on the subject.

The role plays are presented in a uniform format. Each begins with a brief introduction followed by a list of objectives. Finally, step-by-step instructions are provided. Black-line masters for student handouts and role cards follow these instructions.

CONCEPTUAL BASIS FOR THE CREATIVE ROLE-PLAYING EXERCISES IN SCIENCE AND TECHNOLOGY (CREST) SERIES

The *Creative Role-Playing Exercises in Science and Technology* (CREST) *Series* focuses on science-related social issues of concern in contemporary public policy formation. The role plays are designed to help students develop information-processing and decision-making skills needed to deal effectively with such issues.

Several major concepts – science, technology, conflict, values, costs, benefits, and public policy – and two important skills – risk assessment and decision making – guided the development of these exercises. This brief introduction elucidates the importance and interrelationship of these concepts and skills, both for the development of the CREST role plays and for effective classroom use of these materials.

Each CREST exercise guides students in analyzing an important science-related social issue by applying the concepts of *science, technology, conflict, values, risks, costs, benefits, decisions,* and *public policy.*

Human society is obviously the general forum for the issues considered in CREST. Yet it is important to remember that human society exists as part of a natural system in which complex physical, chemical, and biological processes interact. *Science* is the means by which the natural system – including human society – is understood. George C. Homans has written this explanation:

> Any science has two main jobs to do: discovery and explanation. By the first we judge whether it is a science, by the second, how successful a science it is. Discovery is the job of stating and testing more or less general relationships between properties of nature....Explanation of a finding, whether a generalization or a proposition about a single event, is the process of showing that the finding follows as a logical conclusion, as a deduction, from one or more general propositions under specified given conditions.[1]

Science, then, has helped humans understand more clearly how physical, chemical, biological, and social processes work. It has also enabled human society to be less immediately dependent on nature; fewer and fewer humans interact directly with nature for their livelihood. This interaction is mediated by complex social systems and technology.

Technology modifies and magnifies human impact on nature by extending human energy. In turn, natural influences are, to some degree, controlled and altered through the application of technology. Technology is embodied in ideas as well as physical artifacts and encompasses tools as simple as stone scrapers and as complex as nuclear power plants. Its many forms include instruments, containers, machines, and facilities.

Science and technology complement each other. Science leads to clearer understanding of natural processes, which in turn leads to more effective manipulation of nature. This manipulation opens avenues for further exploration, discovery, and explanation.

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1. Homans, George C., *The Nature of Social Science* (New York: Harcourt, Brace, and World, Inc., 1967), pp. 7, 23.

Since technology has increased specialization and division of labor, every individual has become more dependent on the work of other individuals. Each individual's economic role is tied directly and indirectly to a large number of others; it accounts for only one step toward providing needed goods and services. This means that the productive process is more susceptible to disruptive social forces – for example, a strike by transportation workers. As a result, technology has brought about a greater need for rules, regulations, and laws. Philip Wagner explained the relationship between applied technology and increased regulation as follows:

> Through ingenuity and effort, man's technical and economic institutions mediate between the raw environment and human life, but this less immediate dependency is only complementary, not opposite, to ultimate dependence upon nature. The strategy that so releases man from simple and immediate dependence upon the moods of nature rests completely upon planned and organized behavior. The price of liberation from direct dependence on the natural environment is subjection to societal regulation.[2]

Much is yet to be learned about technology and its impact on nature and society. Questions about the long-term effects of technological systems must be given serious consideration, as must questions about the ability of the natural systems to withstand, absorb, and/or recover from these effects.

The potential for the occurrence of an event with negative consequences – the *risk* – is increasingly the focus of *conflict* over technology. Such conflict occurs between individuals, groups, and organizations who differ in their assessment of the risks, *costs*, and *benefits* of a given application of technology. These perceptions are strongly influenced by the backgrounds, experiences, education, and *values* of the parties involved in the conflict. Several additional factors may contribute to or heighten such conflict. Private interests often seem to be in opposition to public interests. Among the questions most vehemently argued are those concerning who derives the benefits from the technology and who bears the costs and faces the risks. Determining an "acceptable" level of risk may also contribute to the conflict.

Thus, both the conflicts over technology and the need for cooperation stemming from its use stimulate the making of public policy – general decisions that "prescribe ways of handling a 'family' of situations."[3] To be truly effective, such policies (regulations) must be complemented by enforcement efforts. CREST role plays focus on both the making and enforcement of public policy.

In both making and enforcing public policies related to technological issues, a major goal is to manage risk. Risk management is a complex discipline which, for purposes of simplicity, we have broken down into four major steps: (1) defining (analyzing) the risk, (2) identifying alternate courses of action, (3) analyzing the costs and benefits of each alternative, and (4) selecting a course of action. These four steps are integrated into CREST simulations as follows.

A problem situation or decision occasion – for example, the proposed building of a nuclear power plant – establishes the conditions to be considered. Students first conduct an analysis of the risks implied by these conditions. This analysis typically centers on three major questions:

- What are the potential adverse effects associated with these conditions?
- What is the magnitude of these adverse effects?
- What are the probabilities that these adverse effects will occur?

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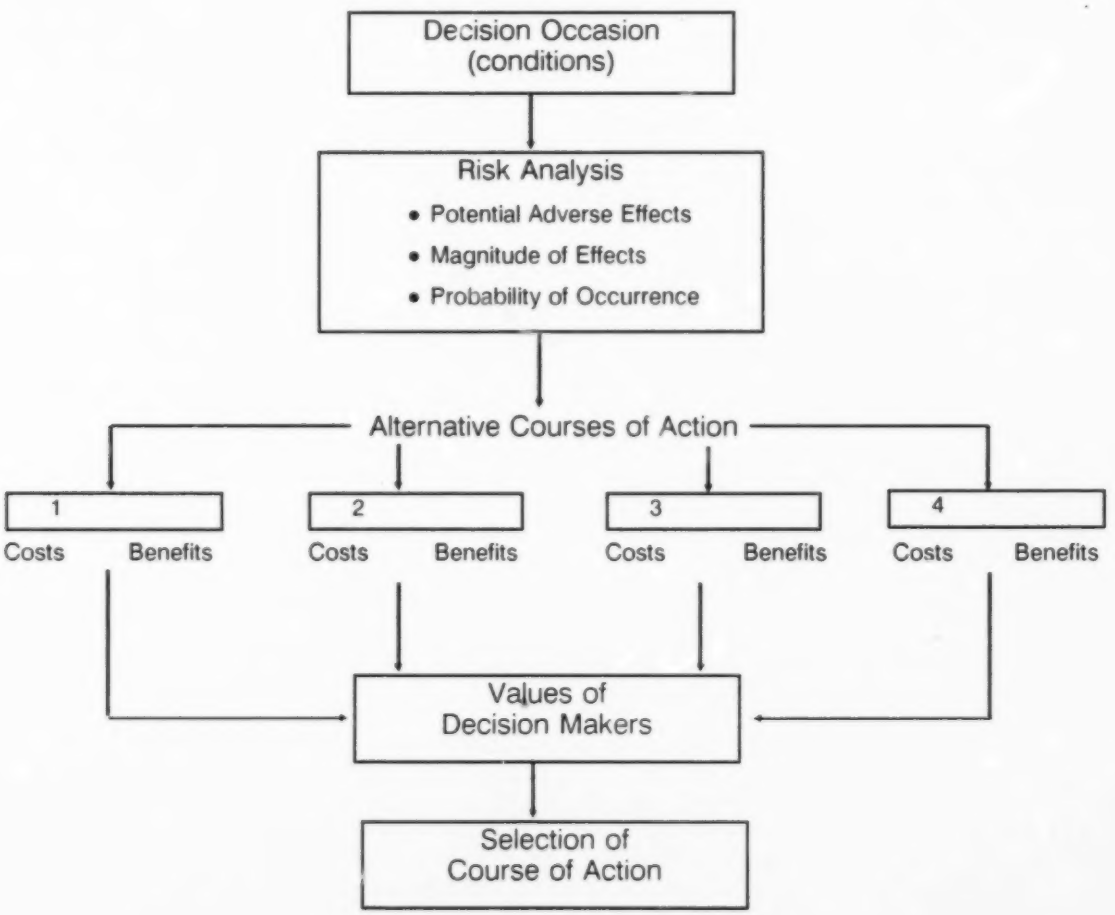
2. Wagner, Philip, *The Human Use of the Earth* (New York: The Free Press of Glencoe, 1970), pp. 62-63.

3. Benne, Kenneth D., and Max Birnbaum, *Teaching and Learning About Science and Social Policy* (Boulder, CO: ERIC Clearinghouse for Social Studies/Social Science Education and Social Science Education Consortium, Inc., 1978).

The adverse effects may be defined in terms of their imminence, reversibility, and distribution. Attention is also paid to who will be exposed to these effects, whether this exposure is voluntary or involuntary, if effects are incremental, and the way in which these effects are perceived by different individuals and groups. The magnitude of the effects may be measured in terms of the health and safety (both physical and psychological) of human beings, the degradation of the environment or depletion of resources, the costs in dollars, or a combination of these. Computing the probabilities of these effects occurring is often extremely difficult because comparative data is lacking. For example, there has never been a meltdown of a nuclear reactor, but does that mean that the probability of such a meltdown is zero?

With this analysis of risks completed, the next step is to identify alternative courses of action. For purposes of CREST simulations, student groups represent extreme arguments and a compromise position between the extremes. Each group outlines the costs and benefits of the alternatives, which are then carefully weighed in a simulated public hearing. Of course, the importance assigned to each factor considered will vary from individual to individual. Costs may be measured in dollar value, loss of opportunity, physical damage, and a number of other ways. Benefits may be measured in increased economic opportunities, decreased risks, growing profits, and a host of other factors. The assessments of the costs and benefits of each alternative are filtered through the values of the decision maker, and a course of action is selected. The process may be graphically represented as shown below.

RISK MANAGEMENT



This risk-management process, then, should aid in the resolution of conflicts related to technological issues and facilitate the decision-making process, which can also be defined by a number of steps. Several models of the *decision-making* process are available. The model employed in CREST activities is not unique, but it provides direction and is readily understood. It also closely parallels the risk-management model presented above.

The decision-making model includes the following steps:

1. Carefully defining the issue or problem to be considered. (Risk analysis can be helpful in this step.)

2. Recognizing the interests and values of different individuals, groups, and/or organizations concerned with the issue or problem.

3. Identifying alternative courses of action (as in risk management).

4. Locating and using relevant information.

5. Identifying and analyzing the probable consequences of each alternative. (Cost/benefit analysis is useful for this purpose.)

6. Selecting an appropriate course of action.

7. Evaluating the course of action once implemented.

A word of caution is appropriate here. While these steps appear to form a linear process, in reality they do not. Locating and using information is, for example, important in each of the other steps. Furthermore, new or additional alternative courses of action may be recommended after others have been carefully analyzed.

Each case considered in the CREST activities contains ample opportunities for teachers and students to explore these important concepts and sharpen risk-management and decision-making skills.

OVERVIEW OF THE ROLE PLAY

This role play considers the dilemma faced by a community whose landfill is nearing capacity and faced with closure. The case is set in the fictional community of Hanson, in the state of Parkland.

Students are assigned roles representing Hanson City Council members, scientists, government officials, Hanson residents holding various views regarding on the issue, and other interested individuals. The students participate in a simulated city council hearing to present arguments related to the pros and cons of various ways of handling Hanson's solid waste disposal in the future. Three major alternatives are considered:

- Build a waste-to-energy incinerator.
- Build a new landfill.
- Institute a mandatory recycling program combined with a new landfill.

Students are organized into groups representing the three positions on this issue and a decision-making group, the Hanson City Council. Through several days of research, the groups compile evidence to support their respective positions. To facilitate the research component of this activity, each group contributes the information they have compiled to a classroom resource center where all participants can obtain equal access to the information.

The culminating exercise for this activity is a public hearing, during which the three advocacy groups present their positions, supported by data they have collected, to the city council. Through analysis and questioning, the city council must reach a majority decision on the issue. A discussion analyzing the different viewpoints and the decision-making and risk-management processes concludes the activity.

The role play requires approximately seven class periods to complete; Handout 2 provides a schedule of activities.

OBJECTIVES OF THE ROLE PLAY

After participating in Oh, Garbage!, students will be better able to:

1. Explain and discuss the social, political, and economic facts that influence decisions made on public policy issues of science and technology.

2. Identify and describe the central conflict involved in a problem requiring social action and decision making.

3. Clearly state the interests and values involved in a problem situation.

4. Systematically analyze the risks in a problem situation and consider ways to minimize those risks. For example: What are the potential negative effects (risks)? Of what magnitude are the potential effects? What is the probability of the occurrence of these effects?

5. Identify or state alternative solutions to a problem situation.

6. Identify and analyze the probable consequences of particular courses of action.

USING THE ROLE PLAY

To prepare for the activity, reproduce the handouts as indicated below:

1. Background Notes: Waste Disposal (1 per class member)

2. Oh, Garbage Activity Timeline (1 per group)

3. Instructions to Group Leaders (1 per group)

4. Risk Assessment (1 per group)

5. Press Release (1 for city council group)

6. Oh, Garbage Group Worksheet (1 per advocacy group)

7. City Council Group Worksheet (1 for city council group)

8. Suggested Resources on Waste Disposal (1 per class member)

9. Waste Disposal Data Packet (1 per group)

10. How to Run a Public Hearing (1 per city council member)

Before beginning this activity, teachers and students should read Handout 1, which contains background information on the issue of waste disposal. This reading will be critical in providing you and your students the background needed to participate fully in the activity. You might assign the "Notes" as a homework reading the day before the simulation is to begin.

Day 1: Introduction

A. To introduce the activity, ask student to generate a list of the kinds of trash they generate in a day. Do they know what happens to this trash in their community? How is it disposed of? Tell students they are going to take part in a simulation focusing on the issue of garbage disposal.

B. To insure that all students have a firm grasp of the facts of this simulation, compile a Hanson waste disposal fact sheet on the chalkboard. Much of the information for this fact sheet can come from the "Background Notes." The fact sheet should clarify, in the students' own words, what the issue facing Hanson is.

C. Highlight the specifics of the role-play situation and introduce students to the decision-making steps outlined in the "Conceptual Basis for the CREST Series" (pp. 2-5).

D. Assign each student a role and distribute role cards.* Names with initials may be played by males or females. Divide the class into the following four groups. Allow 10-15 minutes for participants to read their role cards and introduce themselves to their groups.

*If the class has fewer than 30 students, the same relative size should be maintained for each group. The unused role cards should be added to the data compiled for that group, since the information in them is important for the group to consider. For larger classes, students can work in pairs on single roles.

City Council

D.L. Pena
Al Moscovics
Ellen Benedict
Clarence Hagan
Christine O'Reilly
L.T. Wu
G. Johnson

Build an Incinator

Sean Dutton
Ruth Weber
T.C. Watanabe
Robert Kleinberg
Rita Munoz
C.C. Kirkpatrick
M.Q. Brown
D.L. Smith

Build a Landfill

M.L. Hintz
Marian Zellers
Harry Escalante
Neal McCabe
Shirley Washington
B. Walsh
S. Komata
E.M. Novitsky

Mandate Recycling

A.W. Landau
Mark Talarico
Lynn Gregory
Brad Rutkowski
R.J. Rashad
J.T. Ramos
O.A. Totten

E. Distribute to each group a copy of Handout 2 and quickly review its contents. Identify one or two leaders for each group. They will be responsible for ensuring that the group attends to its tasks. Each group leader should receive a copy of Handout 3.

F. The initial group task is to begin to assess the risks involved in solving Hanson's waste problem. *Students should use information from the group members' role cards*. The questions on Handout 4 should be used to guide discussion in each group.

G. (Optional) As homework, students should become completely comfortable with the information in their role cards. Teachers might assign students a re-reading of the background notes from the perspective of their roles.

Day 2: Preliminary Hearing and Intragroup Discussions

A. As a class, take five minutes to review the information compiled yesterday on Handout 4.

B. The city council should then conduct a *brief* (approximately 15-minute) preliminary classwide hearing focused on the following major questions:

- What are the potential negative effects of the proposed alternatives for disposing of Hanson's waste?
- How extensive will these effects be?
- How likely is it that these effects will occur?

Be sure the city council members understand that at this point everyone is operating with very little data. There will be some disagreement about the potential risks, especially their magnitude and the possibility of their occurrence. In trying to assess the potential risks, the council might focus on the *worst* that could happen and identify the various positions on how likely it is that it will happen. More extensive discussion of the risks will take place during the public hearing on Day 6.

C. Following the preliminary hearing, the city council members prepare a news release on Handout 5. This news release should be reproduced and distributed to the other groups.

After completing the news release, the city council members should begin to consider the alternative courses of action provided on Handout 7. The group should identify important questions related to each alternative for use in guiding the discussion during the public hearing.

While the council members are preparing the news release, the three advocacy groups should complete Parts I and II of Handout 6. This is the first step in preparing presentations on their positions. As the groups begin work, they should identify their proposed courses of action and discuss reasons for their positions. The reasons should be listed in the lefthand column of the worksheet. *Group leaders should see that each group member identifies at least one reason for that group's position. Careful reading of the role cards will facilitate this process.*

The following are some of the key arguments that can be made by each of the three advocacy groups. Students can find many of these arguments set forth in the "Background Notes" and in their role cards. During research on Days 3 and 4, groups will seek specific supporting data for the arguments they choose.

Building an Incinerator

- An incinerator will provide a long-term, if not permanent, solution to the garbage disposal problem.
- Building an incinerator will provide jobs for people in Hanson.
- The incinerator will generate energy that can be used to meet some of Hanson's power demands.
- Because the incinerator will generate energy, it will help offset the costs of operating it.
- The quality of Hanson's water supply will be protected.

Build a New Landfill

- A new landfill will be less costly than an incinerator.
- Experience with landfills will allow one to be built that is safe to the environment.
- Air pollution will be prevented.
- People will be happy because they will not have to change their habits.
- Landfilling is an appropriate match for Hanson's size and location.

Mandate Recycling

- Resources will be saved through reuse.
- The amount of garbage to actually be disposed of will be reduced.
- Pollution will be prevented.
- People will become more aware of the garbage problem as a result of their recycling efforts and will then cut back on the garbage they produce.

- Hanson will receive positive publicity regarding its environmental efforts.

Days 3-4: Research

NOTE: A major component of this activity is to involve the students in research on the topic of waste disposal. Each group of students will be responsible for locating information from a variety of sources to support its position on the issue. Each group will collect at least one piece of information per person which they will use to support their arguments. They will share these materials with the rest of the class through a classroom resource center on Day 5.

Ideally, the teacher will be able to photocopy these materials for inclusion in the resource center. If this is not possible, students should check out materials for classroom use.

A. Distribute the list of suggested resources provided in Handout 8. Not all of these resources may be available to all schools and communities. Students should be encouraged to consult the local library as well as the school library, to contact local organizations, and to look for information on this topic relevant to their own state or region. Also, distribute to each group a copy of Handout 9, "Waste Disposal Data Packet," which contains a glossary, diagrams, and other general information. Materials in this packet should supplement but not replace library research.

B. The city council group will use Part II of Handout 7 as a guide to its library research. Members must identify important questions for each alternative course of action, locate information related to these questions, and record the references on the worksheet. This process will help them prepare for the public hearing. To question each of the groups after their presentations at the meeting, council members must have a clear understanding of all the information collected through research.

C. While the council members are conducting their research, the three advocacy groups complete Handout 6 in preparation for the hearing. This will require them to find information to support the reasons they outlined on Day 2 for their positions.

Teachers should remind students that the quality of each group's presentation, and ultimately its influence on the final decision, will depend on how rigorously group members conduct their research, how carefully they select relevant data, and how clearly they communicate this information during the public hearing.

Day 5: Resource Sharing

A. To insure that all groups have equal access to information, Day 5 is designed as a resource sharing day. All materials compiled by all groups are to be made available in a classroom resource center. Tables at the back of the room or boxes with file folders can serve as the resource center. Each group should spend the first half of class looking at materials compiled by others. Instruct students to make notes of how these new materials might affect their own evidence, how to counter opposing or conflicting material with their own evidence, and so on. *The city council group AND THE TEACHER should be very careful to become familiar with all the evidence compiled.*

B. During the last half of class, the three advocacy groups should go through their group worksheet and finalize arguments for the hearing to take place on Day 6. Each group should discuss how its presentation will be made and pick a spokesperson and three witnesses to present at the hearing. The spokesperson for each group will present the main arguments and supporting information; each witness will be responsible for adding some new perspective and information. The witnesses should not merely repeat the same points made by the spokesperson. Remaining group members will act as prompters during the hearing and thus should be confident of all evidence and procedure.

C. The city council members should spend this time studying Handout 10. They should also review all evidence in the data packet in order to be able to respond to all groups during the hearing.

At the end of Day 5, each of the four groups should be fully prepared for the public hearing.

Day 6: Public Hearing

A. The city council should conduct an open meeting according to the schedule outlined on Handout 10. The group advocating a new landfill should make its presentation first. The spokesperson should briefly present the major arguments; three witnesses will present additional points. They should all refer to specific references when supporting their arguments. Following each presentation, the city council members should take several minutes to question the group to clarify its position. The pattern should be repeated for the build-an-incinerator group and the mandate recycling group. During the meeting, the council members use the questions they identified on their worksheet to guide discussion. They should also ask each group for information on the costs and benefits of their proposed course of action. Part III of Handout 7 will be useful for this purpose.

B. After all three presentations have been made, an open question/answer and discussion session should be held.

C. When the discussion is completed, allow each group two minutes to plan a one-minute final statement. Spokespersons should present the final statements in the same order as the original arguments.

D. The city council members should then hold a brief five-minute discussion in which they reach a decision on the issue. The council should then announce the chosen course of action to the other groups.

Day 7: Final Discussion (Debriefing)

This phase is crucial in helping students recognize what steps they have followed in the risk-management/decision-making process.

A. Each group should spend five minutes discussing how the panel's decision will affect the group members and the community.

B. Hold a brief class discussion to identify the various ways the decision will affect different individuals.

C. Next, have the class turn its attention to some of the key issues in the case. The following questions can be used to help guide the discussion:

- How important is the question of waste disposal to society? Why?
- How did concerns about health hazards affect the decision in this case?
- How did concerns about economics affect the decision in this case?
- What role, if any, did the federal government play in this case? What role, if any, did the state government play?
- What is your personal position on waste disposal? Did this activity affect your position? If so, in what way?
- Which pieces of information in the data packet were most convincing? Least convincing? Why?
- Which spokespeople were most convincing? Did you accept the testimony of government officials, company spokespeople, scientists, and regular citizens equally? Explain.

D. The class should consider carefully the decision-making and risk-management process, using the following questions:

- Did all groups recognize the same risks? Why or why not?

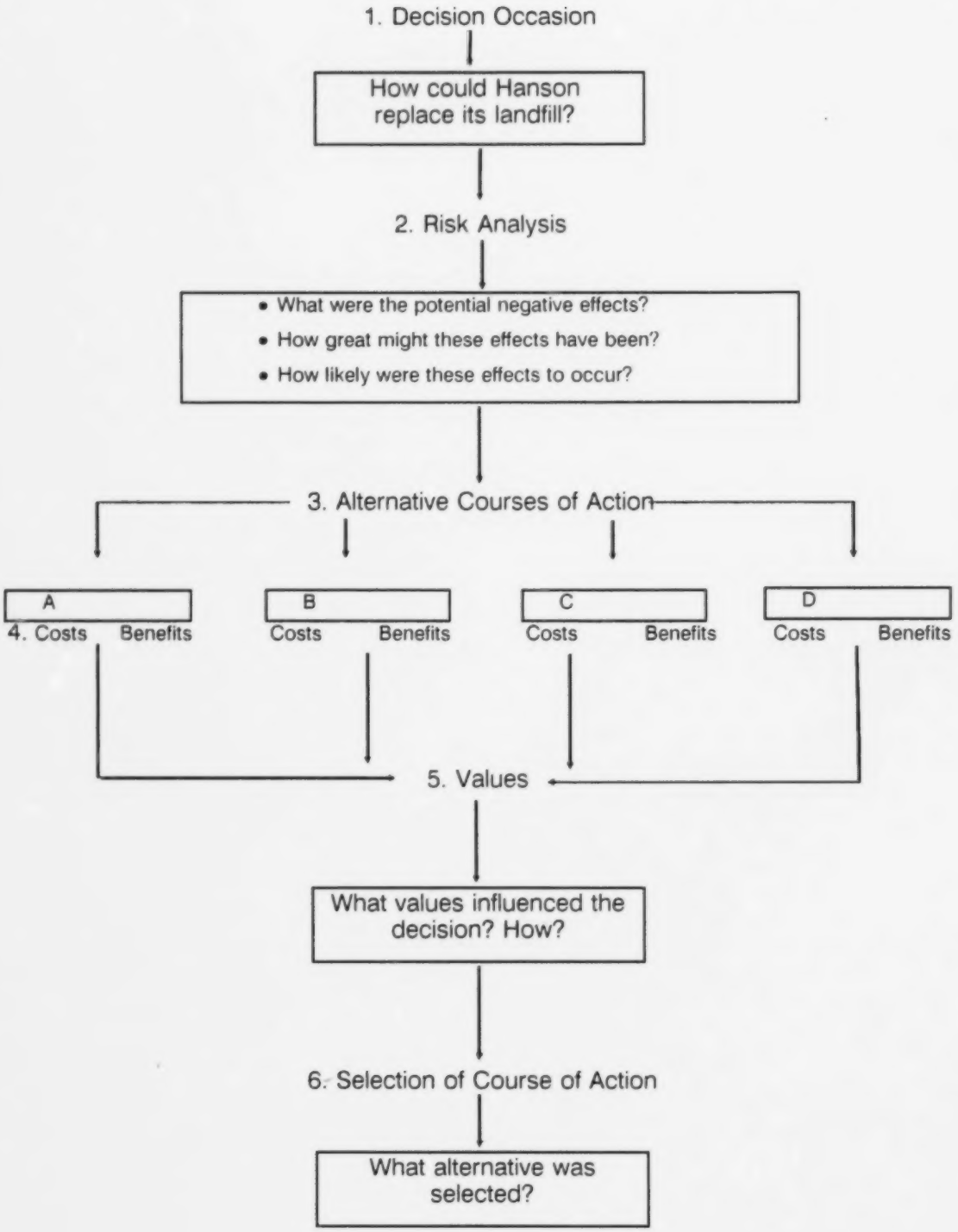
- Were there any risks on which everyone agreed? What evidence was used to identify these risks?
- Which risks were seen as most serious? Why? Which were seen as least serious? Why?
- Who faced the risks? Did they voluntarily face these risks?
- Do you think it is fair for businesses or government to create risks for people without their knowledge or approval? Why or why not?
- What values influenced the positions held by the different groups? How did these values affect the conflict over the case?
- What role did technology play in this conflict? Did it help create the problem? Add to it? Help resolve it? Explain your answer.

E. Finally, turn the students' attention to the decision-making process. Have them review the six decision-making steps followed in this activity. Then use the framework on the following page to review the process they followed in the case. As they answer the questions, fill in the framework on the chalkboard. This page may also be reproduced and assigned as homework at the end of Day 6.

Ask the students to match the six decision-making steps with the six parts of the framework on the following page. The following is a brief description of how they should match up:

Decision Making	**Risk-Management Framework**
Defining the Issue	1. Decision Occasion 2. Risk Analysis
Recognizing Interests and Values	5. Values
Identifying Alternatives	3. Alternative Courses of Action
Locating and Using Information	All
Identifying Probable Consequences	4. Costs and Benefits
Selecting Course of Action	6. Selection of Course of Action

F. To provide closure, ask each student to share the most significant information he/she gained concerning waste disposal or how he/she would now vote on a public referendum on this issue.


1. Decision Occasion
How could Hanson replace its landfill?
2. Risk Analysis
• What were the potential negative effects?
• How great might these effects have been?
• How likely were these effects to occur?
3. Alternative Courses of Action
A
4. Costs
Benefits
B
Costs
Benefits
C
Costs
Benefits
D
Costs
Benefits
5. Values
What values influenced the decision? How?
6. Selection of Course of Action
What alternative was selected?

BACKGROUND NOTES: WASTE DISPOSAL

The United States has a special "genius" for creating solid waste, or garbage. According to a *U.S. News and World Report* special report,

> We produce 400,000 tons of trash a day, making us the world's leading discarders. New Yorkers generate almost twice as much trash per person as do Parisians. About one half of the volume of our trash is from packaging alone. And U.S. know-how keeps creating new forms of trash, from the 16 billion disposable diapers a year to mountains of computer printouts. By the year 2000, each American will generate 6 pounds of junk a day – roughly double the 1960 output. (*U.S. News and World Report*, December 14, 1987, p. 60)

The United States also faces a genuine crisis in garbage disposal. Landfills, for years the most common and cost-effective method of garbage disposal, are filling up. By 1995, over one half of the existing dumps will be closed. And few new ones are being built. Most major cities are already facing this crisis. Yet few are addressing the problem with serious long-term programs. For example, many New England and northeastern cities with no working method of garbage disposal now ship or truck their garbage to other states for disposal in landfills there.

Disposal Technologies

Three basic technologies currently exist for garbage disposal. They are landfilling, incineration, and recycling.

Landfilling. Landfills, one of the oldest waste disposal technologies, are large pits dug into the ground. "Sanitary" landfills are covered over each day with dirt to keep trash from spreading in the wind and to keep pests away.

Landfilling has recently been criticized for several reasons. First, landfills require a large amount of open land, something few communities – especially in the densely populated eastern United States – still have. Land prices alone have made landfills far less cost-effective than they once were.

Landfills have become less effective as the nature of garbage has changed. With the introduction of more and more chemical wastes (plastics, pesticides, etc.) since the 1940s, landfills are no longer dealing with just biodegradable waste – wastes that break down in nature. The introduction of chemical wastes into landfills has created a serious problem with toxic leachates. Toxic leachates are chemicals that mix with rainwater and seep into the ground. These leaching chemicals contaminate the water table, endangering water supplies. Landfills also pose air pollution problems as volatile chemicals evaporate into the air.

When these contamination problems were proven in the 1960s, engineers responded with new designs and technologies in landfilling. Landfill liners and systems to collect leachates and pump them away from landfills were developed. Geologic factors such as groundwater level, composition and porosity of soil and bedrock, and geologic stability are now seen as critical factors in selection of landfill sites. However, heated debate continues over whether technological innovations do, in fact, guarantee that landfills will not leach toxic substance and chemicals.

Incineration. Incineration is a process of burning garbage. Years ago, many communities and even private houses and apartment buildings had their own incinerators. However, the discovery that these incinerators were contributing heavily to air pollution led to a ban in the 1960s. New high-technology, high-temperature incinerators were developed in the 1970s and 1980s to correct the air pollution problem. The new incinerator technology has the added advantage of providing hot water and steam energy as by-products of garbage burning. This technology is called waste-to-energy incineration

(WTE). In 1986, about 6 percent of the garbage in the United States was incinerated. By the year 2000, it is estimated that 30 percent of the garbage in the United States will be incinerated.

People supporting incineration cite several advantages. Waste-to-energy incinerators can burn enormous volumes of garbage daily, making them ideally suited for long-range garbage disposal plans. Moreover, these incinerators burn at extremely high temperatures, thus reducing the volume of ash – the incineration end product – that still must be disposed of in landfills. Finally, waste-to-energy incineration is cost-effective because it produces energy that can be used to power the incinerator itself or provide electricity to the community.

Opponents of waste-to-energy incineration point out that this technology *must have* large quantities in order to produce hot water or steam energy. Thus, waste-to-energy incineration is not suitable for areas with low volumes of garbage. Moreover, waste-to-energy incinerators are very expensive; average construction costs range into the millions of dollars.

Opponents also point out that incineration creates its own set of pollution problems. Fly ash – the ash that escapes out smokestacks – causes air pollution. More significant, the Environmental Protection Agency has determined that the ash collected from the bottom of incinerators contains high concentrations of heavy metals such as arsenic, which should be classified as toxic waste. When this ash is dumped into municipal landfills, it threatens to create ground and water pollution as serious as any from chemical leaching.

Recycling. Recycling is collecting waste and converting it into something usable. Although recycling cannot stand alone as a garbage disposal method, it can take care of approximately 65 percent of waste if the waste is properly separated. Glass, metal, and paper are commonly recycled materials. Food and yard waste are also recyclable as compost. Even some plastics can be recycled.

Supporters of recycling claim that it is the most cost-effective, environmentally sound, and far-sighted garbage disposal method. It saves energy and natural resources and reduces pollution. Recycling is cost-effective because the sale of recyclable material defrays the cost of pick-up, separation, and transportation.

Finally and perhaps most importantly, recycling gets at the source of the garbage disposal problem by significantly reducing what we actually throw away. Because it requires individual commitment and energy, recycling changes people's attitudes and sense of responsibility about garbage, creating a long-term impact on garbage production.

Recycling also has significant drawbacks. It is not a comprehensive garbage disposal program but must be used in conjunction with another method. It simply reduces the amount of garbage to be dumped or incinerated. Recycling is only cost-effective if good, steady, and convenient markets are found for the materials. Towns lacking ready access to a buyer of glass, tin, or paper, for example, will not be able to support a recycling program. Because recycling depends on the cooperation of individual citizens in sorting and packaging recyclable materials, it can be difficult for communities to undertake programs. However, more and more communities and even the state of New Jersey have recently enacted mandatory recycling programs as part of their garbage disposal method.

Clearly, there are no clear-cut choices in garbage disposal for the future. For every community, large or small, the issue of selecting a garbage disposal program brings with it serious economic, social, environmental, health, and political issues. The decision of where to locate a garbage disposal facility, no matter what type, usually creates an uproar from some segment of the citizenry. Homeowners do not want a facility near their homes. They fear increased noise, traffic, and pollution; health risks; a drop in home values; and so on. If facilities are planned for undeveloped land, environmentalists and citizens may complain of risks to the environment and changes in the character of the community.

This Simulation

This simulation focuses on the city of Hanson in the state of Parkland. Located at the junction of two rivers in southeastern Iowa, Hanson has a population of 285,000. The Hanson River flows to the south of the city, and the Ames River flows along its eastern side. Hanson's population density is about 800 people per square mile. Most people live in single-family homes with yards although there are several large apartment complexes in the central part of the city and in the subdivision near Central Landfill. The area around Hanson has a very low population density – only 48 people per square mile. Most of Hanson's residents are politically conservative.

Hanson has many factories that produce food products and farming equipment. Insurance and publishing companies also employ many of Hanson's residents. The area surrounding Hanson is agricultural. Land prices are high. The major crops include corn, soybeans, and oats. Cattle and hogs raised in this area are sent to meat-packing companies in Hanson to be processed. Dairy farms are also common in the area. The average annual income in Hanson is $12,000, the state average.

Hanson's drinking water comes from the large underground aquifer. The aquifer is located beneath a thick layer of limestone, which helps control groundwater pollution. The annual precipitation is 30 inches of rain and snow. This precipitation helps feed the aquifer and ensure a constant source of water for Hanson and nearby towns.

Regulations established by the Parkland National Resource Council say that "no landfill can be built within 15 miles of a river, lake, or other surface water source used for agriculture or the general public." The regulations also strictly regulate the release of gases and other emissions into the atmosphere.

Since 1956, the community has disposed of its municipal solid waste (garbage) in Central Landfill. A report submitted to the city council at the end of last year states that Central Landfill will reach capacity and must be closed within two years. The city council must:

- Thoroughly examine the methods of garbage disposal available to this community.
- Evaluate the advantages and disadvantages of each method.
- Select a method or combination of methods to be put into place before the existing landfill is closed.

In the simulation, you will take the roles of Hanson City Council members or citizens favoring one of the disposal technologies. City council members will work to make a good decision; other citizens will work to make the best case possible for their favored technology.

OH, GARBAGE ACTIVITY TIMELINE

	Day 1	Day 2	Day 3-4	Day 5	Day 6	Day 7
Hanson City Council	•Participate in introductory activities •Receive role assignments, form groups •Prepare for preliminary hearing	•Conduct preliminary hearing •Prepare and distribute press release •Receive Handout 7; begin research	•Conduct research in order to prepare questions on alternative courses of action •Prepare for running hearing	•Compare research findings in class •Finalize preparation for running hearing	•Conduct hearing •Listen to presentations of other groups •Question other groups on costs/benefits of alternative courses of action •Reach decision	•Discuss how Hanson will be affected by decision •Participate in class discussion and debrief
Build a New Landfill Build an Incinerator Mandate Recycling		•Participate in preliminary hearing •Identify reasons for group's course of action •Begin research	•Research •Identify supporting evidence	•Compare research findings in class •Select spokesperson and three witnesses •Prepare presentations for meeting	•Make group presentations •Answer questions from other groups •Listen to other groups' presentations •Ask questions of other groups	

INSTRUCTIONS TO GROUP LEADERS

Your primary tasks are to assemble your group and guide the group in preparing a logical argument for its position. Help the group select a spokesperson and up to three witnesses who will be called on to speak at the hearing. Each group member should present and explain at least one reason for the group's position. Your group should try to provide as much strong evidence as possible to support its position. Be sure everyone has looked carefully at the available data. You should also consider all the consequences of the various alternatives being discussed.

RISK ASSESSMENT

It is important to understand the implications of the issue facing your group. One way of doing this is to *assess the risks involved in each alternative for disposing of Hanson's waste*.

Use the following questions and information from your role cards to make this risk assessment.

1. What potential *negative* effects may result from each alternative for disposing of Hanson's waste?

   a. Who will be likely to experience these effects?

   b. Where or how widely will these effects be experienced?

   c. How soon are these effects likely to be experienced?

   d. How easy will it be to reverse these effects? Why?

2. How great are these negative effects likely to be?

   a. How many people and what type are likely to be affected physically or psychologically?

   b. How great is the environmental damage likely to be?

   c. How costly are these effects likely to be?

3. What are the chances that these negative effects will actually occur?

PRESS RELEASE

HEARING HELD TO CONSIDER RISKS OF NEW WASTE DISPOSAL PLANS

At a hearing yesterday, the Hanson City Council discussed the potential hazards of three methods of replacing Central Landfill – building an incinerator, constructing a new landfill, or requiring recycling. Among the questions considered were:

- What are the likely negative effects?
- How great are these negative effects likely to be?
- What are the chances that these negative effects will actually occur?

Potential negative effects identified by various spokespeople at the hearing included...

There was speculation on the extent of these effects. Some witnesses said that...

Much of the discussion focused on the likelihood that these various effects would occur. General feelings included...

OH, GARBAGE GROUP WORKSHEET

PART I: Participants

Name of Your Group's Spokesperson:

_____

Name of Your Group's Witnesses:

_____

_____

_____

Other Group Members:

_____

_____

_____

_____

PART II: A Recommended Course of Action

1. State clearly the course of action your group believes would be best to follow:

   _____

   _____

2. Based on the information *presented in your role cards and in Handout 1*, what are all the possible reasons for your position? For example, if your group advocates building an incinerator, its reasons may include:

   - An incinerator can handle lots of waste; even if Hanson grows, its waste can be handled by an incinerator.
   - Little ash is left to be landfilled.
   - An incinerator can produce energy for Hanson.

   List your group's reasons in the spaces on the lefthand side of the chart on page 2 of this worksheet. Each group member should identify at least one reason.

PART III: Research

Through data card and library research, find information to support each reason you listed above. For example, look at the third reason above – "an incinerator can produce energy." What evidence is available to support this reason? Enter your reference on the righthand side of the chart on page 2.

	Reasons	Supporting Information
A.		
B.		
C.		
D.		
E.		
F.		

PART IV: Costs and Benefits

1. Outline briefly the costs and benefits of taking the course of action recommended by your group. This information will help you clearly state arguments for your position during the public hearing. Cite references you have identified next to specific costs and benefits.

   An example is provided for you here.

   Example: Mandate recycling.

Costs	Benefits
• All garbage cannot be recycled. • Buyers may be hard to find. • Citizens may not want to separate trash and may vote council out of office.	• Energy is saved, along with natural resources. • People learn to create less trash. • Recycled items can be sold to generate funds.

Your Group's Alternative Course of Action:

_____

_____

Cost	Reference	Benefit	Reference

Use a separate sheet of paper if necessary.

CITY COUNCIL GROUP WORKSHEET

Your group is charged with making a decision on what to do with Hanson's garbage when Central Landfill is full. You must decide what is to be done on this issue. Of course, many questions must be raised and answered. Remember in asking questions to keep the characteristics of your community in mind.

PART I: Alternative Courses of Action

As a group, you should clarify the *possible* courses of action that may be taken in this case. List these alternative courses of action below (remember, each alternative or regulation should consider WHAT, HOW, and WHO):

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

PART II: Questions for the Public Hearing

During the public hearing, you will want to ask questions of each group to help clarify their arguments. This will help you make a good decision. Each role has several questions or concerns. These should be listed, along with other questions that come to mind, in the appropriate areas below. Some questions may be asked of more than one group. Finally, you will spend time researching answers to these questions and educating yourselves. You want to be knowledgeable decision makers. Place the references you find that you think help to answer the questions on the worksheet.

ALTERNATIVE 1: _____

_____

	Question	Reference
A.		
B.		
C.		
D.		

ALTERNATIVE 2: _____

_____

	Question	Reference
A.		
B.		

C. _____ _____

_____ _____

_____ _____

D. _____ _____

_____ _____

_____ _____

ALTERNATIVE 3: _____

_____

	Question	Reference
A.	_____	_____
	_____	_____
	_____	_____
B.	_____	_____
	_____	_____
	_____	_____
	_____	_____
C.	_____	_____
	_____	_____
	_____	_____
D.	_____	_____
	_____	_____
	_____	_____

PART III: Costs and Benefits

For each alternative presented during the meeting, outline the costs and benefits of taking that course of action. COMPLETE THIS SECTION DURING THE HEARING. A partial example for one alternative course of action is provided for you. Be sure to add costs and benefits as they are mentioned by the groups and to ask for clarification where necessary. This will help you make your final decision.

Example: Mandate recycling.

Costs	Benefits
• All garbage cannot be recycled. • Buyers may be hard to find. • Citizens may not want to separate trash and may vote council out of office.	• Energy is saved, along with natural resources. • People learn to create less trash. • Recycled items can be sold to generate funds.

Group 1, Proposed Course of Action: _____

_____

_____

Cost	Reference	Benefit	Reference
_____		_____	
_____		_____	
_____		_____	
_____		_____	

Group 2, Proposed Course of Action: _____

_____

_____

Cost	Reference	Benefit	Reference

Group 3, Proposed Course of Action: _____

_____

_____

Cost	Reference	Benefit	Reference

SUGGESTED RESOURCES ON WASTE DISPOSAL

Listed below are some journal articles, library resources, and contact organizations *to get you started* on compiling information for the upcoming hearing. **Note:** Some of your best information will come from recent newspaper and magazine articles, so be sure to check the *Readers' Guide to Periodical Literature*, *Magazine Index*, and any newspaper indexes available in your school or local library.

General Library Resources

Annual Editions: Environment 89/90 (Guilford, CT: Dushkin Publishing Group, 1989). A collection of more than 35 articles on critical environmental issues.

Burning Question, The: Garbage Incineration Versus Total Recycling in New York City (New York: New York Public Interest Research Group, Inc., n.d.).

Environment (Boca Raton, FL: Social Issues Resources Series, 1973-1989). A loose-leaf "vertical file" containing hundreds of newspaper and magazine article reprints.

Facts on File (New York: Facts on File, Inc., 1989). A weekly digest and index of news, compiled from major national and international newspapers.

Incineration. The Burning Issue of the 80s. A Discussion Paper (Arlington, VA: Citizen's Clearinghouse for Hazardous Wastes, Inc., 1985).

Land Disposal...The Dinosaur of Disposal Methods (Arlington, VA: Citizen's Clearinghouse for Hazardous Wastes, Inc., 1986).

Recycling...The Answer to Our Garbage Problem (Arlington, VA: Citizen's Clearinghouse for Hazardous Wastes Inc., 1987).

Journal Articles

"Buried in Garbage," *Washington Times* (January 17, 1986), pp. 6-17.

Diamond, Stuart, "Garbage – Our Wasted Resource," *Newsday's Magazine* (May 6, 1979), pp. 18+.

Glazer, Sarah, "Garbage Crisis," *Congressional Quarterly Research Report* (September 11, 1987).

"Islip: 'The Paul Revere of Garbage'," *Washington Post* (June 20, 1987), p. A23.

Kunes, E., "American Myopia," *Omni* (March 1989), p. 33.

"Oregon Incinerator Offsets Dwindling Landfill Capacity," *World Wastes* (June 1987), pp. 36+.

"Tons of Trash and No Place to Put It," *U.S. News and World Report* (December 14, 1987), pp. 58+.

"Where Will All the Garbage Go?" *Atlantic Monthly* (March 1985), pp. 29+.

Journals

Environment

National Geographic

Science Digest

Science '89

Waste Age

Waste Disposal and Pollution

Contact Organizations

Citizens' Clearinghouse for Hazardous Wastes, Box 926, Arlington, VA 22216.

Governmental Refuse Collection and Disposal Association, 8401 Dixon Avenue, Silver Spring, MD 20910.

League of Women Voters, 1730 M Street, NW, Washington, DC 20036.

National Association of Recycling Industries, 330 Madison Avenue, New York, NY 10017.

National Solid Wastes Management Association, 1730 Rhode Island Avenue, NW, Washington, DC 20036.

Worldwatch Institute, 1776 Massachusetts Avenue, NW, Washington, DC 20036.

WASTE DISPOSAL DATA PACKET

This packet contains documents to help you prepare for the upcoming city council hearing. The documents are:

I. A Glossary of Waste Disposal Terms
II. The Garbage Revolution
III. Background on Landfills
IV. Background on Incineration
V. Background on Recycling
VI. The Economics of Garbage Disposal

Use the information in this packet to supplement your library research.

I. A Glossary of Waste Disposal Terms

Appropriate Technology – The technology that best meets the needs of the people, economy, and environment of the community. For example, a minivan is a more appropriate technology for a family of eight than a sportscar.

Baghouse – Fabric filter that captures pollutant dust from incinerator smoke.

Biodegradable – Organic material that decays readily in nature.

Chemical Revolution – Since World War II, replacement of natural products with those made by humans.

Disposal – Process of getting rid of something.

Electrostatic Precipitator – Electrical charges used to remove pollutant dust from incinerator smoke.

Fly ash – Residue left after garbage is incinerated.

Garbage – Unwanted or useless material thrown away by people; does not include sewage (any waste that goes through plumbing).

Groundwater – Water beneath the earth's surface.

Incinerator – Device in which waste is burned.

Landfill – Hole in the ground into which garbage is placed.

Leachate – Material (such as chemicals) that leak out of a landfill and permeate the surrounding ground.

Market – Place where a product can be sold.

Methane – Natural, explosive gas produced when bacteria consume organic matter.

Monitor – Check, observe critically.

Nonbiodegradable – Not readily decayed in nature.

Population Density – Number of people in a given area (for example, one square mile).

Porosity – Degree to which a substance is permeable by water.

Recycle – Reuse.

Sanitary Landfill – Landfill in which garbage is covered daily.

Scrubber – Device that mixes incinerator smoke with a liquid lime solution to neutralize acid; sludge is produced.

Solid Waste – See garbage.

Toxic – Poisonous.

Volatile – Explosive.

Waste-to-Energy – Converting garbage to power

Water Table – Depth below which ground is saturated by water.

II. The Garbage Revolution

Up until the 1950s, most of the garbage that a typical American household generated was *biodegradable*. That is, it was natural, organic matter like food, paper, wood, or cloth. When it was disposed of, it would disintegrate or break down into natural, harmless substances.

Since World War II, the world has seen a "chemical revolution," in which natural products have been replaced by humanmade, artificial products. Look at your clothes, for example. Clothes used to be made almost entirely of cotton, wool, and leather. Check your labels – are you wearing nylon, plastic, rayon, polyester? All of these humanmade materials were invented as the result of very recent discoveries in chemistry.

This chemical revolution has, in turn, produced a kind of garbage revolution. People in the United States and most other industrialized nations now produce a new kind of garbage. More and more of the garbage we throw away consists of nonbiodegradable substances – products with complex chemicals that do not disintegrate or decay easily and safely. Some examples are pesticides, petroleum products, metals, and especially plastic. Styrofoam, a product made from petroleum, takes hundreds of years to break down in the environment.

Consider a typical lunch in the school cafeteria or a fast-food restaurant. Do many of the food items you purchase come in individual packages or containers? Which of the following items do you throw away at the end of a meal?

napkins	burger containers
drink cups	plates
utensils	bags
ketchup packets	other _____

Which of these items are biodegradable?

Burger containers – made of styrofoam, some drinking cups – also styrofoam, utensils – made of plastic, and ketchup packets are not biodegradable. Plastic pens, flashlight batteries, video and audio tapes will not break down in the environment. Not only is a lot of our garbage nonbiodegradable, much of it is *toxic* (poisonous) to the environment and to people.

This "revolution" in the nature of garbage means that garbage today is longer lasting and harder to get rid of than it used to be. It can't be burned easily because poisonous or polluting substances within it would be released into the air.

In addition, people today produce more garbage than ever before. The average American throws away approximately 4 pounds of garbage *every day*.

A good example of this increased garbage is packaging. Think back to what you had for dinner last night – meat, vegetables, potato, dessert? Were any parts of your meal prepackaged – such as frozen vegetables, instant potatoes, or microwave dinner?

Many families today rely more and more on prepared, prepackaged foods: frozen vegetables, cake mixes, microwave dinners, and so on. All these products come in wrappers, boxes, or plastic and aluminum containers that are "automatic" garbage. And it's new garbage – that is, waste that we didn't have to worry about very much 15 or 20 years ago when people bought a lot more fresh food.

In industrial countries like the United States, product packaging represents 1/2 of the waste produced by a household. The average American throws away 600 pounds of packaging a year, including junk mail, food containers and wrappings, and drink containers. Altogether, Americans discard about 400,000 tons of garbage a day, enough to fill 40,000 garbage trucks a day. End to end, the trucks would stretch 100 miles. We are the world leader in garbage!

III. Background on Landfills

About 85 percent of all garbage is now dumped in holes in the ground, called landfills. Traditionally, landfills have been a "low-technology" method of disposing of garbage – that is, they do not use a lot of sophisticated tools and equipment.

Some communities simply dump the garbage into the ground. This is called an open landfill. Most communities, however, have a sanitary landfill, where topsoil is spread over new garbage each day. This keeps people, rodents, and weather from dispersing the garbage and helps control air pollution.

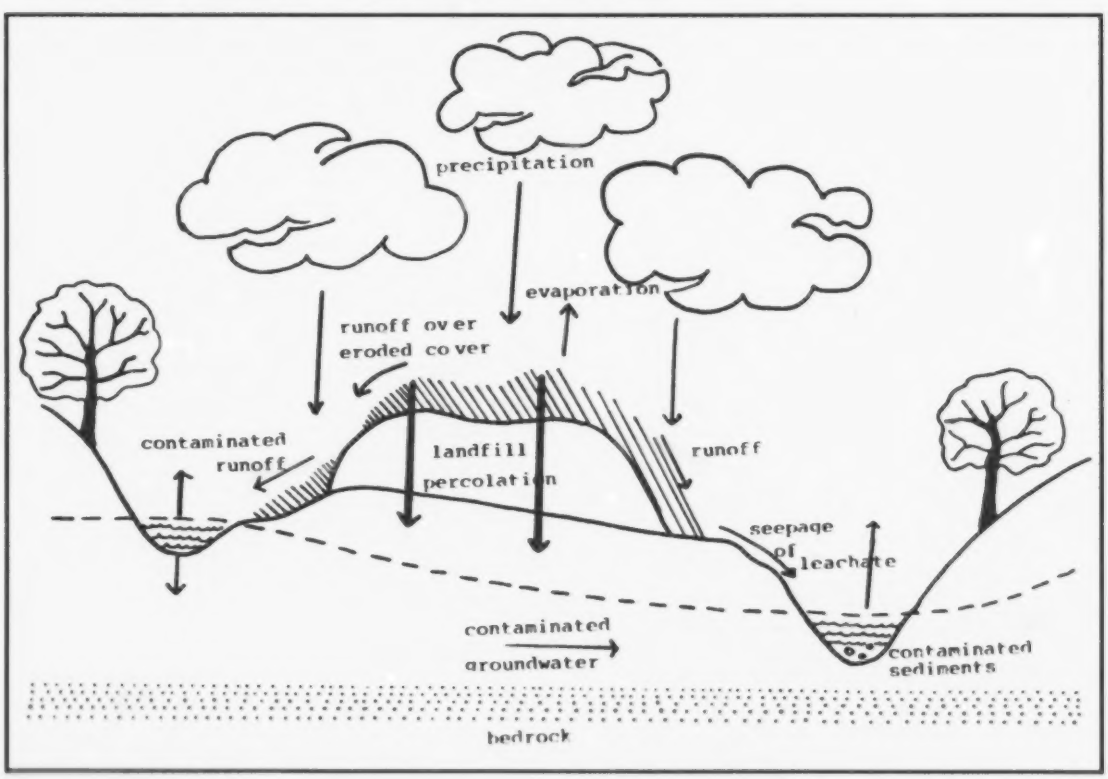
Because landfills have been "low-tech," they also have been an inexpensive way to dispose of garbage. Requirements for a landfill have been an adequate area of land to set aside for the purpose, trucks to haul garbage to the dump site, and other machinery to level off and cover the garbage that has been dumped.

Landfills are relatively simple and low-cost. But they have several important drawbacks. Over time, harmful chemicals and metals in the garbage mix with rainwater that seeps through a landfill. The rainwater carries the chemicals and metals down into the soil and the underground water supply, polluting both. This process is called leaching.

Because of this pollution problem, since 1976 the Environmental Protection Agency has required all new landfills to be built with safety features to decrease the possibility of pollution:

- Plastic or clay liners to prevent leakage
- Drainage pipes to collect liquids
- Equipment to test for pollution of surrounding soil and water.

These safety features make newly-built landfills more expensive.



IV. Background on Incineration

Incineration is a process of burning garbage. In 1986, about 6 percent of the garbage in the United States was incinerated. This is about 45,000 tons of garbage per day. By the year 2000, it is estimated that 30 percent of the garbage in the United States will be incinerated.

The three main types of incineration facilities are the mass-burn facility, the modular facility, and the RDF facility. All three of these incineration facilities can be built so that the garbage is used as fuel to heat water. From the hot water or steam that is produced from the burning garbage, energy is produced. When one of these incineration facilities uses garbage to produce energy, it is called a WTE (Waste-to-Energy) incinerator.

In the mass-burn facility, garbage is dumped into a large storage pit. From this pit, the garbage is fed into the burning area. The garbage is not preprocessed. This means that the only things removed from the storage pit before the garbage is burned are items too large to go through the chute into the burning area.

As the garbage is being burned, a special device collects all fly ash and other particles before they can go up the stack and escape into the atmosphere. The ash that remains falls into an ash pit. This ash is taken to a landfill for disposal.

This kind of facility can handle between 50 and 1,000 tons of garbage per day. Some of the new mass-burn facilities have a furnace that heats water. The hot water and steam are then used as energy sources.

The modular incinerator facility is similar to the mass-burn facility in one way. There is no preprocessing of garbage. But this type of facility is much smaller than the mass-burn facility. The modular facility can burn only 5 to 100 tons of garbage per day.

In the modular facility, burning occurs in two chambers. In one chamber, there is not much air. The garbage burns at a lower temperature, but all the fly ash and other particles are collected before they can escape into the atmosphere.

In the second chamber, there is much more air. This allows the garbage to burn better and at a much higher temperature. The burning process also heats water in a boiler. The hot water and steam are used as energy sources.

The third kind of incineration facility is the refuse-derived fuel (RDF) facility. This kind of facility uses refuse, or garbage, as fuel for the fires that burn the garbage. To work efficiently and to be economical, however, at least 1,500 tons of garbage must be burned every day. In many larger communities, collecting this much garbage per day is not a problem. Garbage is collected from residents as well as businesses and industries.

Five steps are involved in the RDF method of incineration:

1. Garbage is separated; bulky items are removed and shredded into smaller pieces.

2. Metals are removed with a magnet.

3. Highly combustible products, such as paper and wood, are used as fuel for the fire.

4. The garbage is burned at very high temperatures.

5. The boilers above the burning garbage are heated, creating steam that can be used as heat or to drive turbines. The turbines produce electricity.

Each of the three kinds of incineration facilities has advantages and disadvantages.

Mass-Burn Facility:

Advantage – No preprocessing, or separation of the garbage is required.

Disadvantage – Metals or other potentially harmful materials are not removed from the garbage prior to burning. The ash that remains contains toxic substances.

Modular Facility:

Advantage – Garbage is burned twice. This helps reduce air pollution.

Disadvantage – Toxic ash is also a disadvantage. In addition, the modular facility is able to handle a much smaller amount of garbage per day than the mass-burn or RDF facilities.

Refuse-Derived Fuel (RDF) Facility:

Advantage – Garbage is used as the fuel for the fires that burn the garbage.

Disadvantage – Because this type of facility burns more garbage than the other two types, more toxic ash is produced.

Although studies of incinerator ash show it contains toxic substances, the government has not passed any laws concerning the disposal of the ash as a hazardous waste. If laws are passed, they will dramatically increase the cost of dealing with the ash – and will also raise the overall cost of incineration as a garbage disposal method. Special measures required to store, transport, and dispose of toxics could raise the cost of running incinerator plants 10 times. Tipping fees – the charge for dumping waste in a landfill – will go up $50 per ton if the ash is treated as hazardous waste.

V. Background on Recycling

Recycling is a third method of garbage disposal. Recycling is a method of separating and reusing materials recovered from garbage. What kind of materials do you think can be recycled from garbage?

If you said paper, newspapers, bottles, or cans, you are right. The following can also be recycled: some plastics, leaves and grass, food, and motor oil. Recycling can reduce the amount of garbage that must be taken to a landfill or dump 10-50 percent.

With recycling, sophisticated technologies are used to clean materials; remove colors and dyes; melt down and reform glass, metal, and plastic; and reconstitute paper products. Usually, communities do not have these technologies themselves. Instead, they sell their recyclable garbage to industries that use it as the raw material for new products.

Recycling has many advantages, such as conservation of energy and natural resources. Also, because the reusable garbage is actually sold, communities can recover some of their garbage collection costs. But recycling also places a burden on individual citizens, who must separate recyclable materials from their other garbage.

VI. The Economics of Garbage Disposal

One of the first things any community should look at in selecting a method of garbage disposal is the financial costs. In general, you should consider all of the following costs involved in a garbage disposal method:

- Transportation – the cost of getting garbage from the community to the disposal site.
- Construction – the cost of building the facility.
- Operation and maintenance – the cost of running the facility (electricity, labor, maintenance, supplies, etc.).

From the total of these three costs, you can subtract any income gained by selling the products of garbage disposal – for example, the energy produced in incineration, the recycled materials sold, etc.

Let's take a look at each of these costs, starting with transportation. Hauling garbage is very expensive. Experts estimate that it costs as much as $1.00 per ton per mile to transport garbage. Things like gasoline, purchase of the trucks, truck repair and maintenance, licensing, and salaries for the drivers all contribute to the total cost of transporting garbage.

At first glance, $1.00 per ton per mile may not seem like much. But some cities have to transport their garbage as much as 150 miles to the nearest landfill. Of course, they have many tons of garbage each day to dispose of.

Now let's look at what it costs to build a garbage disposal facility. To build a landfill you need open land, bulldozers and heavy machines to clear the land and dig a hole, pipes, liners, and people to do the work. To build a safe landfill, you should also have geologists and engineers conduct tests to see what kind of soil and rocks are in the ground, whether the land is stable, and so on.

Building an incinerator is more complicated than building a landfill. First, you need land, bulldozers and equipment to prepare the land for construction, and workers. In addition, there are a lot of machines and equipment in an incinerator: cranes to scoop the garbage, furnaces to burn the garbage, boilers to heat the water to produce steam, and huge turbine engines to produce the electricity.

The cost of building an incinerator varies with its size and how much garbage it has to burn. The average waste-to-energy incinerator costs about $50 million. Building an incinerator for a large city can cost as much as $430 million.

Garbage recycling facilities can be very simple or complicated. The simplest facility is just a plot of land with large containers for each kind of material you want to recycle. More sophisticated recycling facilities have very expensive machines to sort garbage. How much it costs to build a recycling facility depends on whether your community plans to purchase sorting machinery.

Once a facility is built, it must be operated and maintained. Let's look at what it takes to operate each of the three disposal programs.

To keep a landfill operating, you must have equipment that will bury each day's garbage dump. You must have workers to operate the machinery. For a safe landfill, you should also have people and equipment to test the ground and water around the landfill.

Because there are so many parts and processes in a waste-to-energy incinerator, it is complicated to keep it operating. Of course, you need workers. You also have to keep all the equipment working. If any parts or pieces break down, it can cost a lot to repair them.

Operating a recycling facility takes trucks to pick up and transport the garbage, first to the lot where it is sorted and then to the place where the recycled materials will be purchased. It also takes workers.

Two methods of garbage disposal – incineration and recycling – can also earn some money. You must think about how much money these methods make when you consider the total cost.

Waste-to-energy incineration produces electricity as it burns garbage. A very efficient waste-to-energy incinerator can produce electricity to run itself and for nearby industries or homes. The incinerator company can sell the extra electricity to community users. The money it makes cuts the total cost of incinerator operation.

With recycling, materials are sold to companies that can use them to make new products. The money made by selling recyclable materials can then be subtracted from the overall cost of running a recycling program.

Making exact comparisons of costs of the different methods of garbage disposal is hard. However, one large midwestern city conducted a study and found:

- The cost of recycling is about $30 per ton after subtracting the income from the sale of recyclable materials.
- The cost of landfills is about $90 per ton.
- The cost of waste-to-energy incineration is about $90-$110 per ton, after subtracting the income form the sale of electricity.

HOW TO RUN A PUBLIC HEARING

1. Announce the purpose of the meeting at the beginning.
2. Strictly enforce time limits on each group.
3. In order to maintain control:
    - Have all comments addressed to you.
    - Call on people who raise their hands.
    - As much as possible, give each group equal time.
    - Stress the need for participants to refer to specific sources of information when presenting arguments.
    - Question group members, but don't squabble with them.
    - Have presenters initially state their names, places of residence, if possible, and professions.
4. Your agenda should be:

    a. Build-a-new-landfill group.

(1) Group leader.

(2) Maximum of three additional witnesses.

(3) Questions to that group from the city council members.

    b. Build-an-incinerator group (same as above).

    c. Mandate-recycling group (same as above).

    d. General discussion and questions from the city council members.

    e. Concluding remarks (one minute) from each group.

    f. Council members confer, then announce decision.

    g. Discussion of reasons for chosen course of action.

D.L. PENA

You have been a member of the Hanson City Council for eight years but have lived in Hanson all your life. You were in first grade back in 1956 when Central Landfill opened. You remember your dad saying the landfill, which was 10 miles from town, would last for 100 years. Of course, your dad never dreamed that the city would grow to within a mile of the landfill.

You want to make sure the council chooses a plan that will meet the city's long-term needs. You don't want to face the same problems in another ten years. You are interested in waste-to-energy incineration, but need to have the following questions answered before you reach a decision:

- How much will building a WTE incinerator cost?
- Does Hanson produce enough garbage to make an incinerator cost-effective? Could trash from other communities be burned in Hanson's incinerator?
- What pollution problems does incineration pose? How can they be alleviated?

AL MOSCOVICS

At 68, you are the senior city council member, having served on the council for 28 years. You are a traditionalist and proud of it – America has gone a long way on its traditional values.

You really do not see why there's so much fuss about landfills. After all, Hanson's old landfill has never caused anyone a lick of trouble. It's just filling up too fast. You tend to favor a new landfill, along with programs to extend its life – perhaps baling waste or voluntary recycling.

You are looking for answers to such questions as:

- How much will a new landfill meeting all EPA and state regulations cost?
- How much will transporting garbage to the landfill cost?
- Are there adequate markets for recycled goods in your area?

ELLEN BENEDICT

An editor with a local publishing company, you are known as the peacemaker on the city council. In your four years on the council, you have helped work out many compromise solutions. You enjoy this reputation and work to preserve it. Consequently, you try to go into every discussion with an open mind.

You want to have the following questions answered so you will know the best avenues for compromise:

- How much garbage does our community produce?
- How much does each method of garbage disposal cost?
- How effective is each method?
- What are the pollution and/or health risks of each method?
- What do the people of the community think about the issue?

CLARENCE HAGAN

You were recently elected to represent the new development near the Central Landfill. Many of your constituents are young families living in their first homes or in one of the large apartment complexes in the area. They are concerned about the health problems that could be caused by the old landfill, much less a new one.

You have heard that after a landfill is closed, it may still be dangerous because gases that form as material decays must have a way of escaping or they can explode. In addition, acids formed by decaying material can corrode utility lines or building foundations. As waste settles, the land may shift, posing dangers to buildings on or near it. Thus, you want to ensure that no future building is planned on the old Central Landfill site.

You also want to avoid building another landfill and then having to replace it in 20 years. You are open to either incineration or a new landfill combined with recycling. You need answers to these questions:

- How could recycling be organized to help people in large apartment buildings cooperate with the program?
- Are there enough markets for recycled products to make recycling feasible?
- Combined with recycling, how long could a new landfill last?

CHRISTINE O'REILLY

A 48-year-old lawyer, you see yourself as the most "professional" member of the city council. You believe your background in law gives you insights the other council members do not have. As a result, you are not always the most popular member.

You currently favor an incinerator for Hanson. You believe it is the solution most likely to solve the city's long-term problems. You know of a number of lawsuits related to operation of landfills in other regions of the country, and you want to avoid such problems here.

You are concerned about the following questions:

- How much will building an incinerator fully equipped with pollution control devices cost?
- How much energy will the incinerator generate, given the amount of trash produced in Hanson?
- Is the idea of contracting with other communities to incinerate their trash realistic? Are other communities nationally doing such contracting?
- Are there any current lawsuits involving birth defects or other health problems allegedly caused by smoke from municipal incinerators?

L.T. WU

You are the youngest member of the city council at 25 years of age. You own and operate your own business, a computer programming company. Although you believe that technology offers solutions to many problems, you are not sure that the "high-tech" solution – incineration – is the best solution for this problem. Your questions about incineration revolve around whether Hanson produces enough waste to justify incineration and how the incinerator ash would be disposed of. If a landfill would be needed for that purpose, why not just build a new landfill and use it as the primary disposal method?

You want answers to the following questions before casting your final vote:

- How much would a new landfill cost? Is a suitable site available?
- What other methods could help extend the life of a new landfill?

G. JOHNSON

You are a 44-year-old insurance executive. Your spouse and three children were very proud of you when you were appointed to the city council after one of its members moved out of state. You are a little nervous about running for the council during the next elections, since you have never really asked citizens for their votes before. However, you believe that people in the 1990s want politicians who will do what they believe is right to improve our planet, even if it means a little extra work for individual citizens.

Because you believe so strongly in this vision of citizenship in the 1990s, you support mandatory recycling even though you know some Hansonites think it is too much of a hassle. You believe that our nation's future – even the world's future – is threatened by people's past abuse of the environment. As the world's greatest garbage-producers, American must be among the first to recognize the need to change. Recycling is a first step.

You also support a city-sponsored campaign to educate people about ways to reduce the amount of trash they produce – for example, shopping at farmers markets where there is less packaging on products than at grocery stores. You realize this position will not make grocers happy, but they can respond by not packaging their goods so heavily. We are running out of time to save our planet.

SEAN DUTTON

As Hanson's city planner, you are looking for a long-term solution to the garbage problem. You believe incineration offers that solution.

You know that some Hansonites are worried about air pollution, but three state-of-the-art emission control systems for garbage incinerators greatly reduce air pollution from particles and gases:

Scrubbers: mix emission smoke with a liquid lime solution that neutralizes acids; by-product-sludge.

Baghouses: emission smoke passes through fabric filters that capture pollutant dust.

Electrostatic precipitators: electrical charges remove pollutant dust.

The ash created in Hanson's incinerator could be disposed of by Acme Disposal, a company that specializes in hazardous waste disposal. Acme is located 40 miles from Hanson. To cover the costs of transporting the ash there, Hanson might contract with other cities to incinerate their garbage.

RUTH WEBER

You own a home in one of Hanson's new subdivisions. You purchased the house because it had a lovely yard in which your two children can play. You are afraid that the city may be thinking of locating a new landfill near your home. You have read several research reports on the new "safe" landfills. This is what you have learned:

- Four double-lined landfills studied all leaked within the first year of the study.
- Synthetic liners will eventually leak.
- Liners may slow down the leaking of toxic chemicals, but they cannot prevent leaking altogether.

It seems the question is not whether landfills – even new, hi-tech ones – will pollute, but when they will. And a new landfill would only be a temporary solution. You believe an incinerator would be a safer and more enduring solution.

T.C. WATANABE

You have only lived in Hanson for about three years. You were transferred here by the insurance company for which you work. The California city where you lived before had a WTE incinerator, and you believe it worked very well.

In fact, mass-burn waste-to-energy incinerators are the answer to the garbage dilemma in the United States. Depending on the size, an incinerator can handle over 2,000 tons of garbage per day. Mass-burn facilities can take the entire waste stream – no processing or sorting of garbage is necessary. Mass-burn incinerators reduce the volume of garbage by 70 percent; 30 percent is left as incinerator ash, which can be disposed of in landfills. New technology minimizes air pollution from incinerators. Incinerators produce energy the community can use to reduce electricity costs.

ROBERT KLEINBERG

You are a 27-year-old dentist, a single father with three young sons. You think of yourself as an environmentalist and are hurt that some of your friends are angry with you for not supporting mandatory recycling. You know that recycling sounds good, but you don't think it's practical. These comments from a recent survey taken in Hanson have shown you that you are right:

- I used to recycle in the 1970s, but now I'm too busy to do it. For recycling to work, each household really has to do a lot of work – you must have different containers for glass and tin; you have to wash everything out; you have to tie up your newspapers. Recycling may be cheaper for the community. The tradeoff is that it takes a lot more time and energy for individuals and families. I work all day – I don't have time.
- Recycling is a pastime for hippies and environmentalists. It is not really practical. It can't really make money.

Your 12-year-old son is in charge of taking the trash out at your house. You are not sure he would do a good job separating the trash in the way that recycling would require.

Because of these problems with recycling, you support incineration. At least some energy is generated through this process, and that helps the environment by cutting down on the use of fossil fuels.

RITA MUNOZ

You are a senior vice president at Deerfield Incineration, a company that has built incinerators for several cities. You also operate incinerators in 12 states, including Parkland. You are attending the city council meeting to tell the members about successful operations, like the one in Baltimore, MD.

The Baltimore facility can burn 2,250 tons of garbage per day. All operations, including the unloading of the garbage, are done inside the facility. The garbage is dumped into a pit 225 feet long, 52 feet wide, and 100 feet deep. Giant cranes scoop out garbage and dump it into a chute, where it is moved to a furnace. The garbage is burned on grates at temperatures of at least 2,500 degrees Fahrenheit. The boilers above the furnace produce steam. The steam drives a turbine, and the turbine produces 60 megawatts of electricity per day. About 60 tons of ash are produced per day – a very low 10 percent of total garbage volume. The facility cost $225 million to build. Baltimore had to promise enough garbage daily to keep the incinerator running.

You are not so concerned about the production of dioxins in incineration. It is better to burn municipal garbage and have dioxins produced than it is to burn coal. Coal gives off more acid gases (nitrogen oxides, sulfer oxides, and hydrogen chloride) than can be produced burning garbage. Since Hanson's power plant is coal-fired, they shouldn't be worrying about garbage incineration as an air pollution source.

C.C. KIRKPATRICK

You are going to night school while you work on a garbage truck during the day. You laugh when you hear people saying recycling can work. They haven't seen the condition garbage is in when you pick it up.

In one of your classes, you learned that a variety of social factors contribute to the success or failure of a recycling program. In New Jersey, when experts were trying to decide whether to adopt a mandatory recycling program for the state, they considered several factors:

- Recycling is less likely to work in urban areas with a high population density, people living in high-rise apartments. It is more difficult to get the cooperation of people in such a setting because it's hard to put out five different cans of garbage rather than throwing everything into one communal dumpster.
- Recycling is more likely to work in residential communities with single-family homes that have their own garbage cans.
- Communities in tourist areas who have developed a sense of community pride in their environment may also be more amenable to recycling.

Hanson has some high-density areas and you think it lacks community pride. You favor incineration.

M.Q. BROWN

You are a retired accountant who studies local politics as a kind of hobby. Your children think you go too far, but you have even made the effort to read the annual reports of some companies involved in incineration construction and operation.

You find the following information very impressive:

- In Saugus, Massachusetts, 1,200 tons of garbage are burned each day, producing the steam equivalent of 12 to 17 million gallons of oil per year for a nearby electric plant.
- An incinerator in New York City turns 2,400 tons of garbage per day into enough heat and electricity to power nearby industrial users.
- A proposed incinerator for Denver would burn 450 tons of garbage per day. It would produce enough hot water to heat and cool Denver's airport, the county jail, and some nearby businesses. This would be the equivalent in one year's time of 1.5 billion cubic feet of natural gas or 210,000 barrels of oil and would reduce Denver's public service bill by $3.3 million.

You believe building an incinerator will be good for Hanson because it will generate electricity – and jobs.

D.L. SMITH

A longtime Hansonite, you have finally decided landfilling is no longer a practical solution to the garbage problem. There are just too many people throwing away too much trash. According to a newspaper article you read, we have actually created mountains of garbage. The nation's biggest garbage dump is Fresh Kills, which serves New York City. When that landfill finally reaches capacity at the end of the 20th century, it will be a geographic landmark – at 500 feet high, the highest point on the eastern seaboard south of Mount Desert Island, Maine.

A case in Maine provides another example of the combined effect of population growth and increased waste per person on the garbage problem. A small town that had been using the same community landfill for 100 years realized the landfill would be full within three years. So the town dug another landfill of equal size. Instead of lasting 100 years, that dump was full in 15 years.

You are supporting a municipal incinerator.

M.L. HINTZ

As a geologist, you are well aware of the hazards of landfills – pollution of soil and water through leaching. However, you believe that because the hazards are so well known, they can be handled. The site for a new landfill must be selected carefully, looking for an area where the water supply is not close to the surface, the soil and rock above the water supply are not permeable, and where runoff from the surface of the landfill will not carry harmful chemicals into streams, lakes, or rivers. You would even volunteer to help the city select the best landfill site.

You are more concerned about the fact that people involved in incineration do not take its hazards seriously. As incinerators burn garbage, gases are released into the air. One example of a very dangerous gas given off during incineration is dioxin. Dioxin has been proven to cause cancer in humans. Although air pollution from incinerators can be reduced by using scrubbers and baggers all the harmful chemicals and particles drawn out of the air by the baggers and scrubbers must be disposed of somewhere. The same is true with the ash left over when garbage is incinerated. For every 1,700 tons of garbage burned, almost 300 tons of ash remain. Some of it contains toxic material that is concentrated.

Where do you think this stuff goes? Into landfills, of course. And since the EPA has not declared incinerator ash to be hazardous waste, proper precautions are not taken. That is why you support a carefully constructed and carefully run landfill for Hanson.

MARIAN ZELLERS

You are a 62-year-old retired public relations specialist. Since you worked for the Environmental Protection Agency for 13 years, you feel you are well qualified to speak on this issue. You favor the construction of a new landfill.

In the 1960s, the EPA became concerned about toxic chemicals filtering down from landfills into the groundwater that becomes our drinking water. To remedy this, the EPA passed regulations for new or expanding landfills.

- Landfills must have two separate liners to prevent chemicals from filtering to the ground below.
- Groundwater in the area of the landfill must be checked for contamination.
- Leachates – the mixture of chemicals and water from landfills – must be collected regularly.

Of course, all these measures make landfills much more expensive to operate. You can't just dig a hold in the ground anymore. But these new regulations will insure that landfills are safer to our environment and people. And you believe a landfill is still cheaper than incineration and more practical than recycling.

HARRY ESCALANTE

You are the public works director of a city about 100 miles from Hanson. Your city believes it has a landfill that works.

When your city found that it would exhaust its landfill capabilities within a few years, you began searching for alternatives. By law, closing the existing landfill would require two feet of cover, including six inches of topsoil. The cover would cost the city $750,000.

The nearest potential sites for a new landfill were 10 to 20 miles away. This would mean five trips per day for the city's 10 trucks. The cost of $1.87 per trip made this option too costly.

Instead of building a new landfill, you purchased two machines, a Caterpillar IT12 and a Cat 953 track-type loader. Together with the Cat 613 elevating scarper and the 816 compactor the city already owned, you began baling and stacking the waste on the existing landfill. This changeover will save the city an estimated $6.57 million in hauling and processing costs over the next 10 years. It will also extend the live of the 180-acre landfill about 40 years.

NEAL MCCABE

You are the national president of Citizens Against Pollution, an organization that works for a cleaner environment.

Your organization has commissioned two independent studies of incinerator ash, the residue from burning garbage. You found it to contain dioxins and furans – classified by the Environmental Protection Agency (EPA) as hazardous wastes because they can cause cancer.

The real problem is not so much the existence of these toxic substances in incinerator ash; it is the lack of regulation about the disposal of this material. Currently, incinerator ash can be dumped in municipal landfills as though it were safe. We strongly urge the EPA to enact regulations on the storage, treatment, transport, and disposal of incinerator ash as the toxic waste it is!

Until such regulations are enacted, your organization cannot support building any new municipal incinerators. A new landfill, perhaps combined with recycling, is the only answer.

SHIRLEY WASHINGTON

You are a 52-year-old homemaker and community volunteer. You are currently heading a neighborhood group concerned about construction of an incinerator in Hanson. You have collected 4,200 signatures on a petition that reads as follows:

We the undersigned protest the location of a waste-to-energy incinerator in the northwestern section of our town for the following reasons:

- Air pollution from incinerators is dangerous to our health and our children.
- An incinerator near our neighborhood will lower housing values. Our property will become worthless.
- We do not want trucks carrying smelly, dangerous garbage through our neighborhoods.

This area of town is full of family neighborhoods that have a lot to lose in health, property values, and peace and quiet. Put the incinerator somewhere else – or build a new landfill outside of town.

B. WALSH

You are an engineer with Acme Disposal. In that capacity, you have designed several new landfills for communities in Parkland. Although building a landfill is not as easy as it used to be, you believe landfills are still good options for medium-sized cities like Hanson, which really do not produce enough waste to justify building an incinerator.

In designing and constructing a landfill, you consider such factors as:

- Volume requirements – how much garbage is created per week.
- Site characteristics – what the soil is like, how permeable it is, where and how deep bedrock is, how deep groundwater is, where water will drain, what the surrounding vegetation and land use are.
- Surface water controls – whether gullies or pipes can be used to keep water from penetrating the landfill from above.
- Release of carbon monoxide and methane formed as garbage decays – whether pipes can be inserted into the landfill so that these gases can be released.

When these factors have been properly accounted for in the design, a landfill can be completely safe. Combined with recycling or baling of waste, a landfill can still serve a community for many years.

S. KOMATA

You are a 36-year-old pediatrician. You are violently opposed to an incinerator in Hanson because of the production of dioxin. Dioxin is one of the *most toxic* chemicals known. Birth defects, skin rashes, lowering of the body's defense mechanisms, reproductive disorders, liver disease, and kidney cancer are all associated with dioxin exposure. Furans, close "cousins" to dioxins, have similar toxic effects. Both are commonly found in incinerator emissions.

You do not understand how any responsible citizen can support the release of such toxins into the environment. A carefully monitored landfill is a better answer.

E.M. NOVITSKY

You are an economist who teaches at a local community college. You want the city to consider carefully the costs of the various garbage disposal methods.

You are well aware that landfills used to be very cheap, and some people still think they are. Because of new EPA regulations, however, the costs of landfills have increased dramatically. Landfills must have double liners to decrease leaching of landfill chemicals into the groundwater. They must also have leachate collection and monitoring of groundwater for contamination. For hundreds of years after the landfill is closed, the city must check for contamination of groundwater. A realistic estimate of the cost of landfills must also consider long-term maintenance and safety as well as immediate, short-term costs.

Even considering those costs, however, you believe a landfill is more cost-effective than an incinerator. The cost of building an incinerator can range from $250,000 to $429 million; the average is $58 million. Operation and maintenance costs must also be added in, as must the cost of disposing of the incinerator ash. Furthermore, you are not even sure Hanson produces enough garbage to keep an incinerator going.

A.W. LANDAU

You are a successful marketing manager for one of Hanson's publishing companies, even though you are only 29 years old. You are known for your bold ideas. You believe your company could win many friends – and perhaps customers – both in Hanson and nationally if it committed to using only recycled paper products.

As a first step in your plan, you are supporting a mandatory recycling program for Hanson and have your company's commitment to provide whatever assistance it can in implementing the program. Of course, you do not own your own paper plant, but your company would represent a secondary market for recycled paper. You have also talked to a fertilizer company near Hanson that has agreed to buy some recycled food waste. As a public service project for your company, you would be willing to help the city locate markets for recycled glass and plastics.

MARK TALARICO

As an environmental engineer, you believe that the real heart of the garbage problem is its production. A long-term solution to the garbage problem must focus on reducing the amount of garbage we throw away.

The United States, like other industrialized societies, has become a "throwaway society," manufacturing and buying many products that can only be used once and then must be thrown away. Such practices and attitudes have contributed to our serious garbage problem.

Disposable diapers are a good example. A baby goes through five diapers a day, every day, for at least two years. That's 3,650 disposable diapers. A baby would probably only need 30-40 cloth diapers, because they could be washed and reused. The disposable diaper industry sells *16 billion* diapers a year. And all those diapers go into the garbage!

If we want to try to solve our garbage problem by reducing the amount of garbage we produce, we are going to have to change our attitudes and habits. We might learn a lesson from some nations that are less wealthy than the United States. People in countries of Africa, Asia, and Latin America throw away far less garbage per person than Americans do. (A person in Calcutta, India, only throws away about one pound of garbage a day. The average American throws away nearly four pounds of garbage a day.) People in these countries cannot afford to waste things. They find useful things to do with their waste, such as feeding spoiled food to pigs.

Mandatory recycling would be a first step toward making people aware of the need to change their attitudes.

LYNN GREGORY

You and your husband farm 300 acres 10 miles outside Hanson. You are afraid that the city will decide to locate a huge landfill or incinerator in the outlying areas near your home.

You believe that both incinerators and landfills pose health problems. You know that tests at municipal incinerators have revealed the following typical polluting emissions, both gases and particles:

Oxides of nitrogen – contribute to smog; cause eye and lung irritation

Sulfur oxides – contribute to acid rain, can cause headaches, nausea, eye irritation

Hydrochloric acid – from burning plastics, contributes to acid rain

Heavy metals (lead, cadmium, mercury) – high concentrations contribute to kidney disease, birth defects, nervous disorders

Dioxins and furans – among the most toxic chemicals, contribute to cancer.

Landfills leach toxic materials into water supplies and can even lead to explosions of methane. In 1984 methane from the Lorton Landfill near Washington, DC, leaked into a nearby prison. It exploded, killing one prisoner and maiming another.

You don't see why people think recycling is so hard. You have been separating household trash for years.

BRAD RUTKOWSKI

A social studies teacher at Hanson Heights Middle School, you teach your students that citizens are responsible for their government and the quality of their environment. You practice what you teach, which is why you want to testify in support of mandatory recycling.

Sure, recycling takes some effort, but it is worth it. Garbage can be reduced by up to 70 percent. That is what has happened in one community with a program that includes mandatory household separation of wastes into four containers:

1. Food and organic garbage

2. Newspapers and clean paper and cardboard

3. Metal, glass, and jars

4. Remaining trash

Households put all four containers on the curb, and all four are collected once a week on the same day. Material from container 1, food and organic garbage, is brought to a city composting plant. When it has been turned into compost, it is delivered to farms. Material from container 2 (paper) is brought to a paper-separating plant and then sold to different markets for recycled paper. Material from container 3 is brought to a separation plant and then sold. Material from container 4, all remaining trash, has no recyclable value and is brought to the landfill.

R.J. RASHAD

You are a college student, majoring in chemical engineering. While you believe in technological solutions, you do not believe that a "high-tech" solution, like incineration, is always best. Recycling, which combines individual effort with technology, is preferable in your mind.

You know that estimates of the amount of garbage and trash that can be recycled vary from study to study. Some studies claim that 65-75 percent of garbage, including glass, paper products, aluminum, and food waste, is recyclable. In 1985, over 500 cities provided some kind of recycling program. These programs reduced the amount of garbage going to landfills in those cities by 15-45 percent. Examples:

- Woodbridge, NJ: 35 percent of garbage recycled; metal, plastics, aluminum, yard waste, paper, and glass
- North Stonington, CT: 50 percent of garbage recycled; glass, tires, paper, tin, cardboard, and aluminum
- Portland, OR: 15 percent of garbage recycled; glass, oil, aluminum, scrap metal, rubber, and paper
- Davis, CA: 31 percent of garbage recycled; paper, glass, mixed metals, and aluminum

Isn't this enough evidence that recycling works?

J.T. RAMOS

You are an environmental consultant for a group called Citizens Against Pollution. You are concerned that city council members see incinerators as a quick-fix for the mounting garbage problem. Just because incinerators are quick and produce some energy for our electricity needs doesn't mean they are a safe or long-lasting solution.

Incinerators are actually more hazardous than landfills for several reasons:

- Incinerators release dioxins, furans, acid gases, and metals into the air.
- 30 percent of the garbage is left over as incinerator ash and must be disposed of in landfills.
- Incinerator ash contains the same toxic substances – dioxins, furans, metals – that cause groundwater pollution when dumped in landfills.

You favor mandatory recycling, with landfilling of nonrecyclable waste.

O.A. TOTTEN

As a 42-year-old minister, you feel you have some insight into human behavior. You believe people in Hanson can be motivated to participate in a recycling program. You believe the case of Woodbury, NJ, supports your view.

In 1982 Woodbury established a mandatory recycling program. The city required all residents to separate their paper, glass, aluminum, garbage, metal, and non-metal objects and place them on curbs for collection.

People complained about the time and diligence it took. Woodbury promoted acceptance of the program in several ways. They monitored trash collection; households that did not separate their garbage did not get their trash picked up. Repeated violators could be fined. Woodbury also promoted participation through community pride campaigns.

By 1985, the town had accomplished 96 percent compliance with the law and now boasts a very successful recycling program as *one* component of its garbage disposal system.

Woodbury sells its recyclable materials to nearby glass companies, paper mills, livestock farmers (food garbage), and Goodwill Industries (clothes and furniture). Yard waste, such as leaves and branches, are composted by the city.

In 1983, 35 percent of the city's garbage was recycled. This saved the city more than $31,000 in disposal fees and extended the life of the landfill.